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WITNESS my hand this
Ninth day of April 2003

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TITLE: GROUND LEVELLING APPARATUS

This invention relates to ground levelling apparatus.

In the earth moving industry, the term "cutting edge" is used to refer to a wear member that is mounted a working edge of an implement such as a grader blade or bucket that cuts into the ground. The wear member is designed and positioned to protect the edge of the implement that would, in the absence of the cutting edge, engage the ground and thus wear prematurely. In this specification, the term "cutting edge" is used in the same sense and the term "knife edge" is used to refer more particularly to the actual ground engaging edge of the cutting edge or, in case no separate cutting edge is provided, the ground engaging edge of the implement itself.

According to the invention there is provided apparatus for ground levelling, the apparatus comprising a carrier that is provided with a straight elongate ground engaging knife edge and a connecting member having a hitch for hitching the carrier to a prime mover, the carrier having a straight bearing portion that is disposed parallel to the knife edge and is arranged in use to bear on the ground as the carrier is moved over the ground by the prime mover thereby to support the knife edge at an elevation relative to the ground that is determined by the elevation of the hitch relative to the ground.

According to the invention there is provided apparatus for ground levelling, the apparatus comprising a carrier that is provided with a straight elongate ground engaging knife edge and is joinable to a connecting member having a hitch that is spaced from the carrier and is arranged to connect the apparatus to a prime mover provided with means for selectively adjusting the elevation of the hitch relative to the carrier as the prime mover moves the carrier over the ground, the carrier having a straight bearing portion that is disposed parallel to the knife edge and is arranged in use to bear on the ground as the carrier moves thereby to support the carrier so that the knife edge is maintained at an elevation relative to the ground that is determined by the elevation of the hitch.

According to the invention there is provided apparatus for ground levelling, the apparatus comprising a carrier that is provided with a straight elongate ground engaging knife edge and is joinable to one end of a drawbar provided at its opposite end with a hitch for connection to a prime mover provided with means for selectively adjusting the elevation of the hitch relative to the carrier as the prime mover draws the carrier over the ground, the carrier having a straight bearing portion that is disposed parallel to the knife edge and is arranged in use to bear on the ground as the carrier moves thereby to support the carrier so that the knife edge is maintained at an elevation relative to the ground that is determined by the elevation of the hitch.

In one aspect of the invention, the distance between the knife edge and the bearing portion is substantially less than the distance between the knife edge and the hitch.

In one aspect of the invention, the knife edge is located between the bearing portion and the hitch.

[illegible] is further discussed with reference to the accompanying drawings in [illegible]

Figure 1 is a somewhat schematic sectional side elevation of one example of a ground levelling apparatus according to the invention;

Figures 2 and 3 are plan views of the apparatus showing respectively a drawbar thereof in an unfolded (working) position and a folded position, used in transporting the apparatus;

Figures 4 and 5 are views of the apparatus from the front, on arrow A in Figure 2, showing a ground wheel arrangement, used for transporting the apparatus, in an unfolded (working) position and a folded position respectively;

Figure 6 is a schematic side view of a levelling apparatus with a modified drawbar.

Referring first to Figure 1, the levelling apparatus 10 comprises a cutting edge 12 mounted on a mounting beam 14 in the form of a steel pipe. The beam is an example of what has hereinbefore been called a carrier. The beam is of essentially the same length as the cutting edge so that the beam supports the cutting edge along the entire length of the latter. The cutting edge is substantially conventional except that it, and the beam, may be rather longer than usual. In the present example the length of each can be in excess of 12 metres. The applicant believes that cutting edges of this length are not commercially available as a single piece so, for economy, the cutting edge 12 may be made up of, say, five shorter pieces, each of 2.4 m length.

The cutting edge 12, or the shorter pieces of which it is made up, have each a knife edge 12a that engages the ground

Short lengths of rolled steel channel bar 16 are welded to the beam along its length to act as a seat for seating the cutting edge 12. Each bar 16 is provided with a slotted hole (not visible in the drawing) that mates with a hole in the cutting edge 12. Mounting bolts pass through the holes and receive nuts 18 by means of which the cutting edge 12 is fixed, in conventional fashion, on the beam. The slots allow for accurate alignment of the cutting edge.

A length of hardened steel flat bar 20 is welded to the bottom of the beam, extending the full length thereof. The beam rests on this bar to support the beam on the ground. The bar 20 also acts as a skid on which the beam is able to slide when the beam is drawn over the ground as will be described.

Care must be taken when welding the bar 20 to the beam to ensure that, after welding, the bar 20 is straight. Similarly, when the cutting edge 12 is being mounted on the beam, care must be taken to ensure that the knife edge 12a is straight and parallel to the bar 20. The beam must be sufficiently strong and rigid to ensure that it does not sag substantially or bend in use.

Referring to Figures 4 and 5, when not being used for levelling, the apparatus can be transported by means of a pair of road wheels 50. These are carried one on each of two legs 52 that are welded to a cross bar 54 to make up a fork 56. The cross bar straddles

the beam so that the wheels are located one on either side of the beam. The cross bar pivots on an axle 57 mounted on the beam and the fork is able to pivot between a transport position, shown in Figure 4 at 60 and a retracted position 62 shown in Figure 5 at 62. The mechanism that causes the fork to pivot is described below.

The apparatus also includes a triangulated drawbar 22. The drawbar comprises a pair of fabricated steel bars 24, 26 that come together at one end 25 (being the forward end of the drawbar) where they are pivotably joined together by means of a pin 27. At their opposite ends 28 the bars are spaced apart and are pivotably joined to the beam 14 by means of pins 30a, 30b located one on each side of the longitudinal centre of the beam and at equal distances therefrom.

At its forward end the drawbar is provided with a conventional hitch bar 32 by means of which the drawbar is pivotably joined to the two lower links or plough arms of the three point hitch (not shown) of a tractor.

The pins 30a, 30b are disposed with their axes approximately vertical to the ground. The bar 24 is a one-piece fabrication and is hence non-extendible. However, the bar 26 comprises two steel pipes one of which 26a slides telescopically into the other 26b. The pipe 26b is pivotably joined to the bar 24 by means of the pin 27. The axis of the pin 27 is parallel to the axes of the pins 30a, 30b. The lengths of the pipes 26a, 26b, and the arrangement of the pins 30a, 30b, 27 is such that the bar 24 is able to pivot about the pin 30a from the working position shown in Figure 2 to the folded position shown in Figure 3. In this movement, the pipe 26a slides out of the pipe 26b, effectively increasing the length of the bar 26. In the working position, the two pipes, one inside the other, make the bar 26 substantially rigid.

A first latch arrangement (located adjacent the intersection between the pipe 26a and the beam 14 and shown schematically at 33a) is provided to lock the two pipes 26a, 26b together when the drawbar is in the working position.. A second latch arrangement (shown schematically at 33b) is provided adjacent the end 34 of the beam. This locks the two bars 24, 26 to each other and to the end 34 of the beam when the drawbar 22 is in the folded position shown in Figure 3. The latch arrangement also locks the bars 24,

26 and the beam together against vertical movement, allowing the drawbar to lift the end 34 of the beam for transport as will be described.

The latch arrangements are controllable by means for example, of flexible lines 35a, 35b that can be led to the tractor. When the drawbar is in the working position, without leaving his seat, the driver pulls the line 35a to unlock the latch 33a. The driver can then manoeuvre the tractor so that the drawbar 22 moves to the folded position. In this movement, the end 34 of the beam sits firmly on the ground and the bar 24 pivots about the pin 30a. The bar 26 pivots about the pin 30b, extending in length telescopically in the process. When the drawbar arrives at the folded position, the latch arrangement 33b automatically locks the two bars 24, 26 against the beam 14 when the drawbar gets to the fully folded position.

The driver can also, again without leaving his seat on the tractor and by pulling the line 35b, unhook the latch 33b and thereby release the drawbar from its folded position. Using the tractor, the driver can then move the drawbar back to the working position in which it is automatically locked by the latch 33a.

Adjacent the end that is pivoted to the beam 14 by the pin 30a, the pipe 24 carries an upstanding post 70. One end of a bottle screw 72 is pivoted through a vertically disposed pin (not visible in the drawing) to the upper end of the post. The opposite end of the bottle screw is pivoted to a horizontally disposed pin 74 carried by a pair of trunnions 76 standing up from the beam, being welded thereto at a position directly behind the post. If the drawbar is assumed to be held in a fixed position, adjustment of the length of the bottle screw causes the beam to rotate about its own longitudinal axis relative to the drawbar. Once set, the bottle screw prevents the beam from further such relative rotation. This is important because, for reasons which will be explained, when the apparatus is being used in a levelling operation, the elevation above the ground of the knife edge 12a relative to the skid bar 20 should be controlled solely by raising or lowering the forward end of the drawbar 22. This would not be possible if the beam was able to rotate freely relative to the drawbar.

The upper ends of each of two link chains 78 are connected to the upper end of the post 70 at points located on opposite sides of the vertical pin and spaced at some

distance therefrom. The lower ends of the chains 78 are connected to the beam, one on either side of the post. When the drawbar is in the working position the chains are set up taut. They serve to brace the post and help prevent twisting of the beam about a line extending in the direction of motion of the apparatus. The bottle screw is unable to prevent such twisting that would in turn, if it was to occur, cause the beam to rotate about its longitudinal axis, through the action of the bottle screw. This is undesirable for reasons already mentioned.

When the apparatus is to be used, the wheels are locked in the retracted position and the drawbar is locked in the working position by the latch 33a. The mechanism for moving the wheels between the retracted position and the locked position includes a bar 80. One end 80a of the bar 80 is pivotably connected to the bar 24 at a short distance from the pin 30a. The opposite end 80b of the bar 80 is pivotably connected to a lever 82 welded to the cross bar 54 of the fork which carries the wheels. When the drawbar is moved to the working position, the bar 24, acting through the bar 80, causes the fork to rotate to move the wheels to the retracted position. When the drawbar is moved to the folded position, the opposite happens; i.e. the bar 24, again acting through the bar 80, causes the fork to rotate to move the wheels to the transport position.

When the wheels 50 are in the transport position, the drawbar 22 is in the folded position, locked to the beam by the latch 33b. The beam is lifted off the ground, supported by the wheels and the hitch. In this configuration, the tractor can tow the apparatus to a new work place. The beam is disposed with its axis in line with the direction of motion of the tractor. This is very convenient for towing the apparatus. If either the beam or the drawbar was disposed athwart the direction of motion of the tractor during towing, the apparatus would not be allowed on public roads without special permission.

In a levelling operation, the height of the forward end of the drawbar is adjusted (by lowering or raising the plough arms of the three point hitch), causing the beam to rotate about its longitudinal axis until the skid bar 20 and the knife edge 12a of the cutting edge 12 are level with each other. This is what may be described as the "normal" working position of the knife edge relative to the skid bar and to the level of

the ground. The applicant has found that levelling with this as well as with conventional levelling apparatus, levelling is optimal when a bank of earth of chosen height, typically about 10 cm, is maintained just ahead of the cutting edge. The height of this bank may vary depending on the condition of the soil. The operator must control the apparatus to maintain the bank at the chosen height. If the operator sees that the height of the bank is increasing, he must cause the elevation of the knife edge (relative to the ground) to be raised. This allows more soil to escape under the knife edge and causes the height of the bank to diminish slowly. If the height of the bank decreases below the chosen height, the operator must cause the elevation of the knife edge to be lowered to allow less soil to escape under the knife edge.

In the present apparatus the elevation of the knife edge is controlled simply by raising or lowering the three point hitch of the tractor and hence the drawbar 22 at the hitch 32. A substantial advantage of the present invention is that the length of the drawbar, which in the present example is equal to about 5 m, is much greater than the distance between the skid pad 20 and the knife edge 12a equal in the present example to about 25cm). The ratio of these distances is 20:1. Thus, if the three point hitch raises the hitch 32 by 20 mm, the elevation of the knife edge, relative to the skid pad 20, is raised by only 1 mm. This enables the levelling operation to be very finely controlled.

The levelling apparatus 100 shown in Figure 6 can be used with a tractor that does not have plough arms. The apparatus 100 has a drawbar 102 that is generally substantially similar to the drawbar 22 of the apparatus 10. In this case, however, the hitch bar 32 is omitted and replaced by a rigid fore-and-aft extending towbar 104. At its forward end the towbar is hitched to the towing hitch 106 of the tractor. At its aft end the towbar is pivoted to the forward end of the drawbar 102 through a pin 108. The drawbar is provided with an upstanding lever arm 110. A double acting hydraulic ram 112 is pivoted at one end to the towbar 104 and at its opposite end to the upper end of the lever arm 110. The ram is connected to the hydraulic system of the tractor and is controllable by the driver. If the ram is extended, the forward end of the drawbar 102 is raised causing elevation of the knife edge to increase slowly. Conversely, if the ram is contracted, the forward end of the drawbar is lowered, causing elevation of the knife edge to decrease slowly.

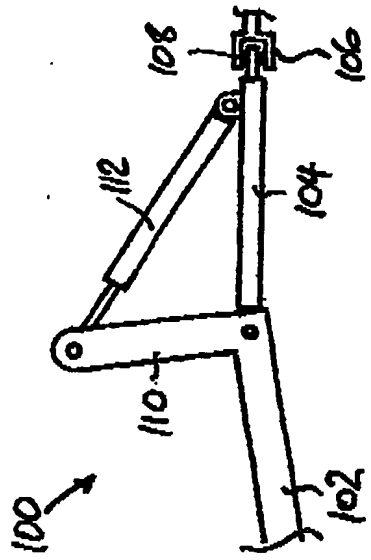

FIG 6

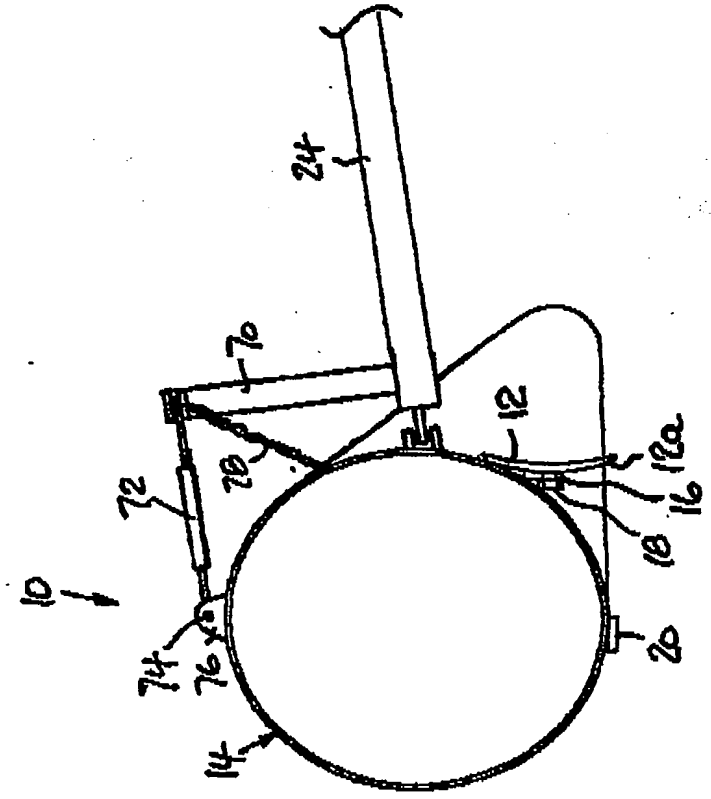

FIG 1.

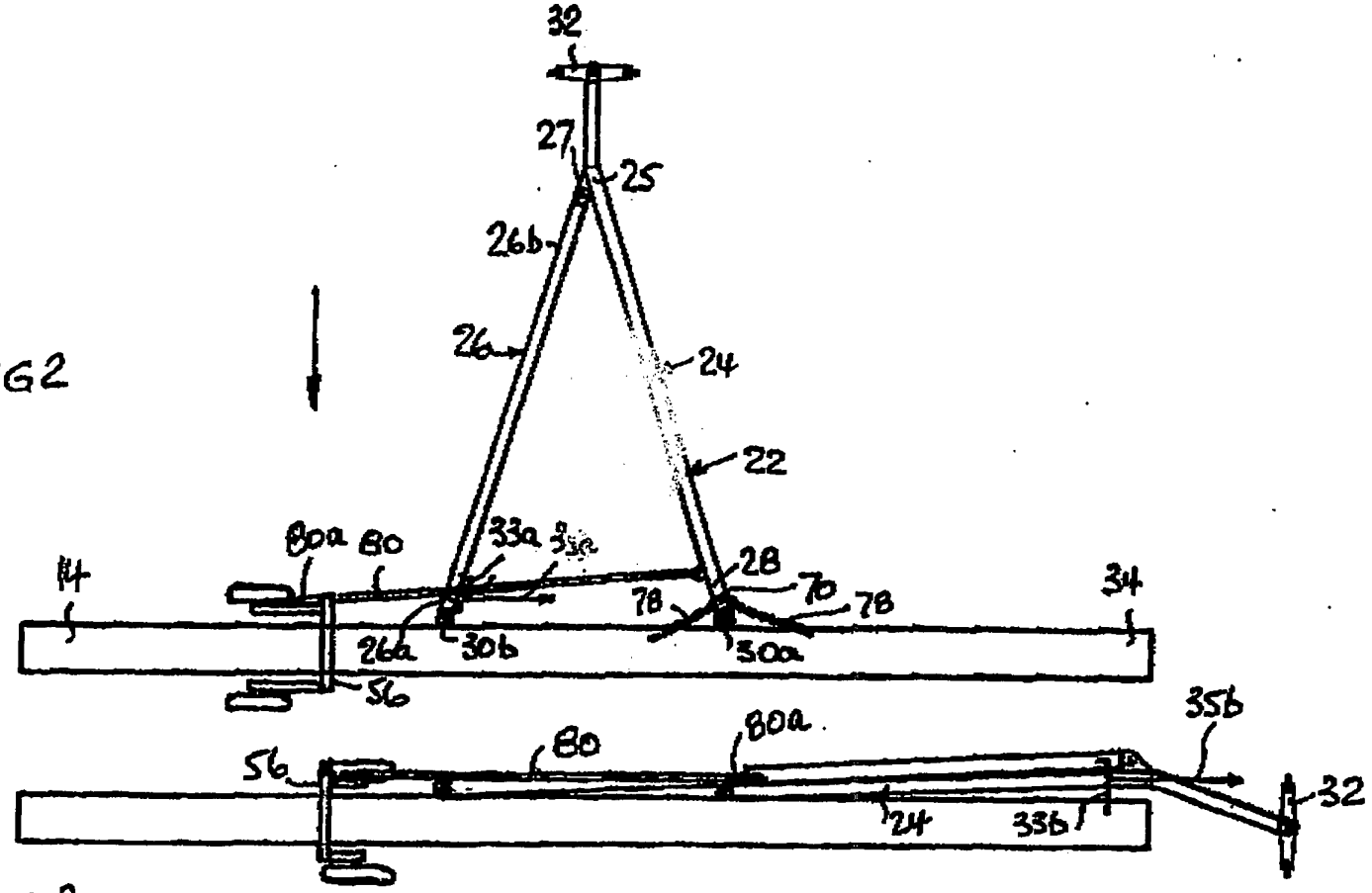
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FIG 2

FIG 3

FIG 5

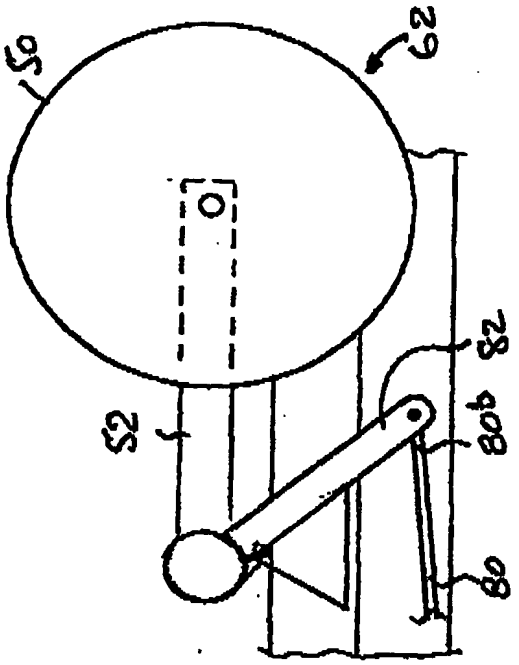
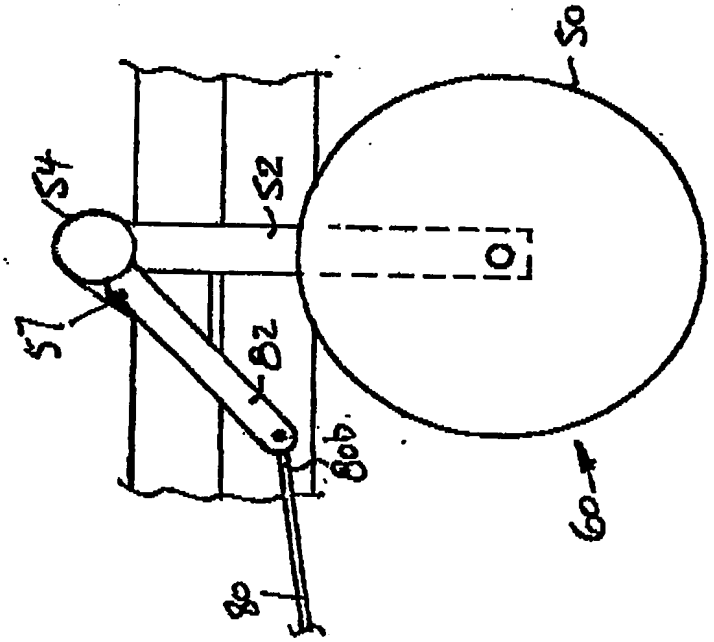


FIG 4



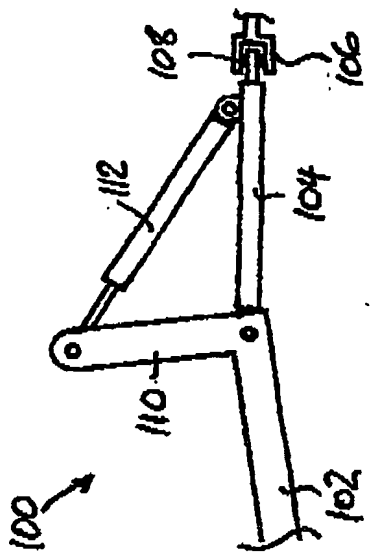


FIG 6

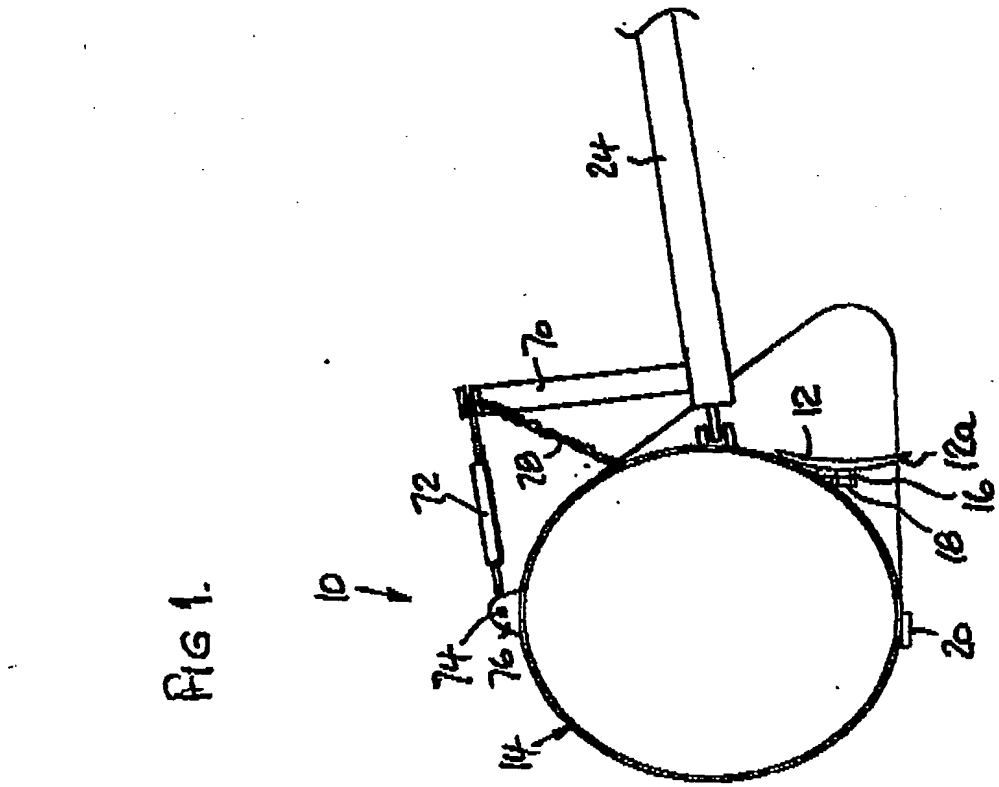
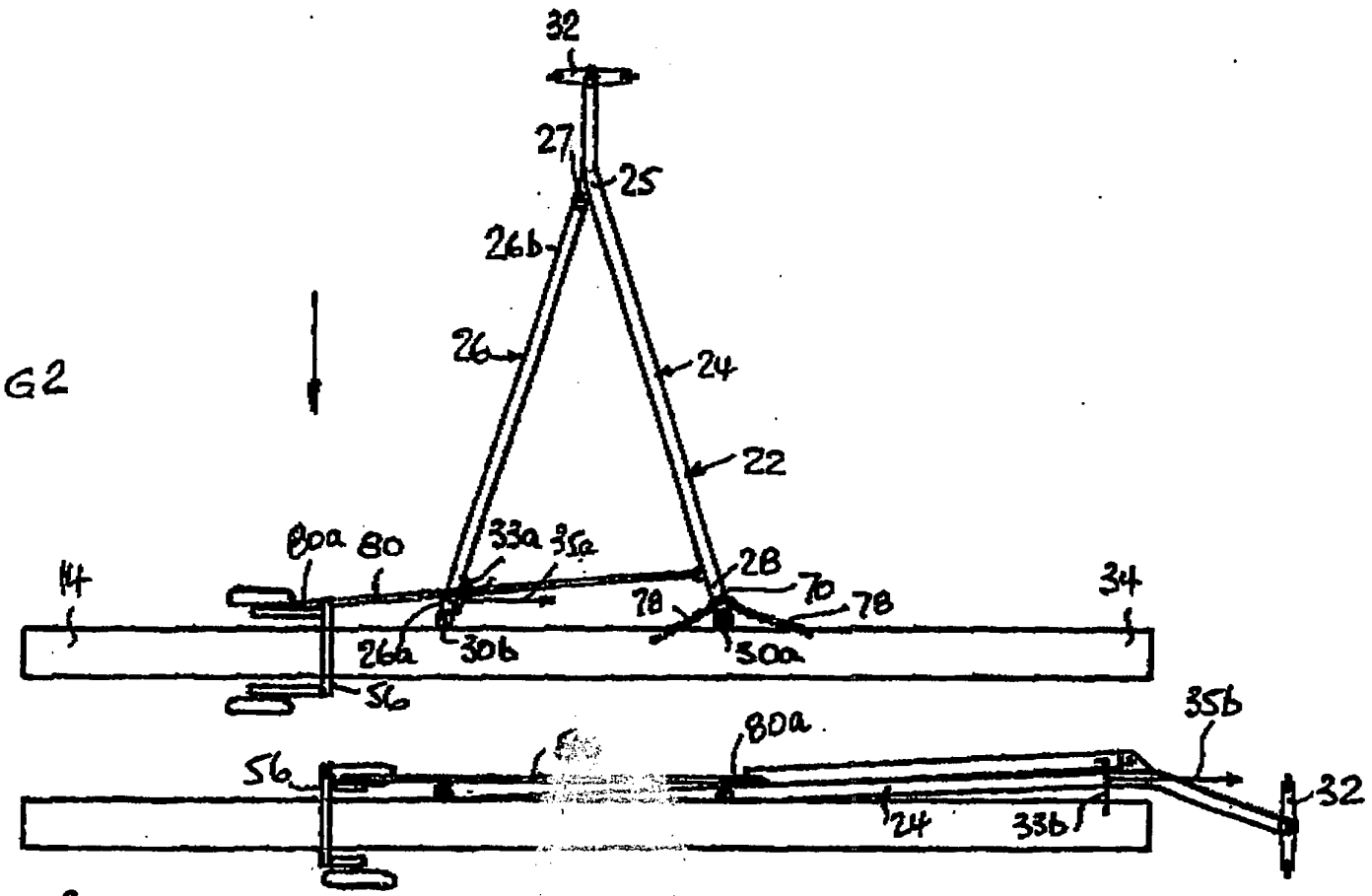


FIG 1.

FIG 2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26b
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33a
35a
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14
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56
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80a
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32
24
33b

FIG 3

FIG 5

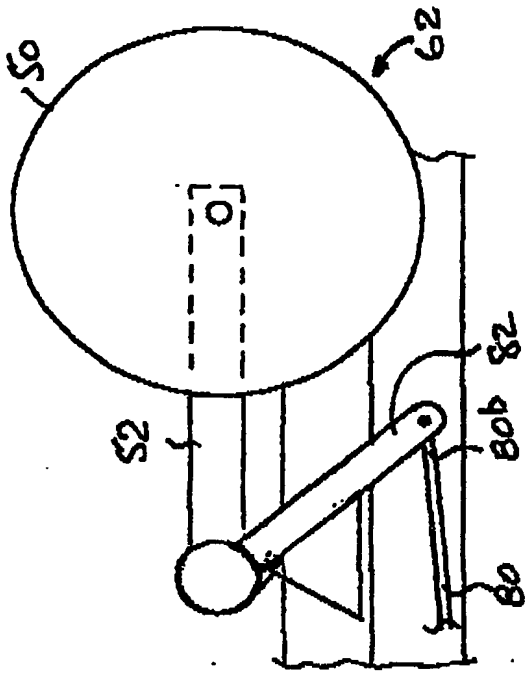
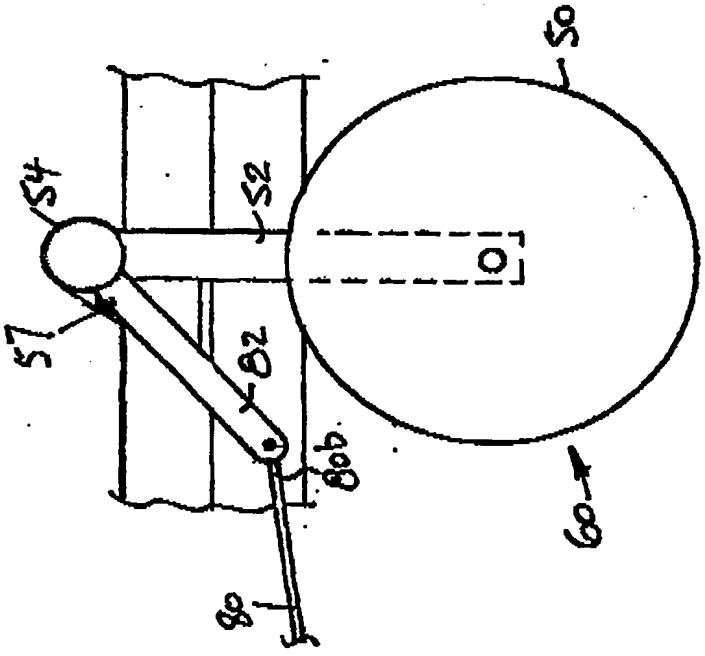


FIG 4



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